INTRODUCTION

The incidence of cerebrospinal fluid (CSF) perilymphatic gushers has been reported to be around 1% in patients undergoing cochlear implant surgery. Various techniques have been used to create a fluid-tight seal around the cochlear implant electrode, including connecting tissue and muscle. As more children with cochlear malformations are being considered for implantation, the increased risks associated with cochlear implants may also include persistent CSF leak and associated meningitis, stressing the importance of obtaining an adequate seal around the cochlear implant.

In a study of 529 patients undergoing cochlear implantation, 6 patients had a perilymphatic gusher at the time of cochleostomy. Obtaining an adequate seal is very important for patients with a perilymphatic gusher. During Valsalva maneuvers, a study of 15 normotensive patients found that their CSF pressures all reached greater than a 25 cm H2O. One patient reached a level of 47 cm H2O; the mean CSF pressure reached 32.3 (range 26-47) cm H2O. Increased CSF pressure can easily occur upon emergence from general anesthetics, which could result in the loss of an adequate seal around a cochlear implant electrode. Cochlear implant electrodes vary in diameter according to manufacturer specifications. The amount of packing that can be placed around the electrode is therefore a function of the cochleostomy diameter in relation to the implant diameter. With a larger diameter cochleostomy, a larger amount of packing can be placed into the surgical opening around the cochlear implant. We hypothesized that the larger amount of packing that can be placed around a cochleostomy will allow for a more reliable seal around the cochlear electrode to a significant degree.

METHODS AND MATERIALS

Human cadaveric temporal bones were used. Modified radical mastoidectomy was performed to expose the basal turn of the cochlea and provide adequate space for the manometer system. Cochleostomy was drilled with a 1.0 mm diamond burr in one temporal bone and with a 1.5 mm diamond burr in the other through the promontory just superior to the round window. Stapes footplate was removed and it was used in 23-25 gage butterfly needle was inserted through this opening and sealed with cocking and cyanacrylate.

Cochlear implant electrode (Cochlear®, Medical Electronics® and Advanced Bionics®) was inserted in standard fashion. Fresh porcine pericardium was used to pack around the composite electrodes. Saline bag was placed on IV pole and the height was adjusted to provide a fixed amount of pressure within the inner ear (Figure 1). Fluorescein dye was injected into the tubing near the needle. Microscope was fixed with a black light source to enhance visualization of any leaking from around the cochleostomy site. Examination for leakage was made at 0, 10, 15, 20 and 30 cm H20. With the Cochlear® implant at 30 cm H2O, 5/10 of the 1.0 mm cochleostomies showed evidence of a leak whereas 0/10 of the 1.5 mm cochleostomies showed leakage (p=0.004). With the Med-El® implants, 2/10 of the 1.0 mm cochleostomy resulted in a leak whereas 0/10 leaked at this pressure with the 1.5 mm cochleostomy (p=0.24). With the Advanced Bionics® electrode, 5/10 of the 1.0 mm cochleostomies resulted in leaks whereas 0/10 leaked at this pressure with the 1.5 mm cochleostomy (p=0.03). We hypothesized that the large amount of packing that can be placed around a cochleostomy will allow for a more reliable seal around the cochlear electrode to a significant degree.

RESULTS

As illustrated in Table 1, no leak was demonstrated at 0 or 10 cm H2O for any implant with the 1.0 mm cochleostomy and no leak was demonstrated at any pressure for any implant with the 1.5 mm cochleostomy. For the Cochlear® implant, no difference was noted between the two different cochleostomy sizes at 0, 10, 15, and 20 cm H2O. However, at 30 cm H2O, 6/10 of the 1.0 mm cochleostomy trials and 0/10 of the 1.5 mm cochleostomy trials were different to a statistically significant degree, p=0.005. For the Med-El® implant with a 1.0 mm cochleostomy, there was no statistically significant difference in the Med-El® implant group when comparing leaks at 20 and 30 cm H2O between the 1.0 and the 1.5 mm cochleostomy (p=0.49 and 0.24, respectively). For the Advanced Bionics® implant, no difference was noted between the two different cochleostomy sizes at 0, 10, 15, and 20 cm H2O. However, at 30 cm H2O, 5/10 of the 1.0 mm cochleostomy trials and 0/10 of the 1.5 mm trials were statistically different, p=0.003.

When comparing the difference between cochleostomy sizes given a particular implant, we found a statistically significant increased incidence of perilymphatic leakage in the 1.0 mm as compared to the 1.5 mm diameter cochleostomy with the placement of Cochlear® (p=0.006) and Advanced Bionics electrode (p=0.003). Conversely, we did not find a statistically significant difference for the Med-El® implants (p=0.24). Also, when comparing rate of perilymph leakage in the 1.0 mm diameter cochleostomy between all electrodes, no significant difference was noted (p=0.18). Likewise, no difference was noted with the 1.5 mm diameter cochleostomy when comparing electrode type, Table 2.

DISCUSSION

Our data suggests that a 1.5 mm cochleostomy may be a superior choice as compared to the 1.0 mm diameter cochleostomy with regards to incidence of perilymph leakage. This can be explained by the more consistent and reliable amount of packing that can be placed in the 1.5 mm cochleostomy. Specifically, it is the relationship between the cochleostomy size and the diameter of the cochlear implant. The Cochlear® and Advanced Bionics® implant is 0.8 mm in diameter at full insertion; with the implant situation in the cochleostomy, this leaves 0.35 mm surrounding the implant in the 1.5 mm cochleostomy and only 0.1 mm surrounding the implant in the 1.0 mm cochleostomy. Subjectively, we noticed that packing around the implant in the 1.0 mm cochleostomy was technically more difficult.

Our results from the Med-El® electrode require more consideration, as we were unable to fully insert the implant into the 1.0 mm diameter cochleostomy. Therefore, an equivalent insertion depth was used for the 1.0 and the 1.5 mm diameter cochleostomies with the Med-El® implant. Like the Cochlear® and Advanced Bionics® implants, no leaks were found at any pressure for the 1.5 mm diameter cochleostomy. With the 1.0 mm diameter cochleostomy, we did have 3 leaks over 50 measurements. The fact that our Med-El® electrode was not fully inserted introduced another variable that clearly confounds our data. In addition, this would result in a number of non-functioning electrodes.

There is also a factor of operator proficiency bias; the Cochlear® electrode trials were all done prior to the Med-El® electrode trials, which were done prior to the Advanced Bionics® electrode trials. The operator noted that meticulous preparation of porcine pericardium strips was necessary to optimize that amount could be packed into a tight space. The fact that the 1.0 mm diameter cochleostomy with the Med-El® implant trials were done last may have introduced the aforementioned proficiency bias, thereby under-representing the relative incidence of perilymph leakage when compared to the other trials.

CONCLUSIONS

The incidence of perilymphatic gushers, although low, is increased in patients with inner ear deformities; with more of these patients undergoing cochlear implantation, one must consider the most effective way to control such leaks. Our objective data and subjective experience point to the improved ability to effectively seal off the space around the implant in the cochleostomy when utilizing a larger (1.5 mm vs. 1.0 mm) cochleostomy size. Therefore, when a perilymphatic gusher is suspected, one may consider drilling a cochleostomy with a diameter significantly larger than the implant diameter in order to allow for adequate packing placement and sealing.

REFERENCES